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Influence of Star paper mill effluent on biomass production and yield at harvesting time of different agricultural crops

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Abstract

Influence of Star paper mill effluent of different concentration on biomass and yield production of four agricultural crop i.e. *Solanum melongen*a (Brinjal), *Cicer arietinum* (Black gram), *Glycine max* (Soyabean)and *Lycopersicon esculentum* (Tomato) was investigated in the field condition. Variable behaviour on pattern of seed germination , root length, shoot length , root and shoot ratio was recorded . Similiarly all four crops showed variability with concentration of dose and yield production at harvesting stage.Biomass production was better in control (only tap water) than plot irrigated up to 10% with effluent but was found suitable at 25% and after that it was deleterious for brinjal crop. However effluent was suitable at 5% dose of black gram and after that it showed adverse effect. Adverse effect of effluent on biomass production was recorded at all different concentration used in soyabean crop, but effluent above 50 % concentration showed a positive response for *L. esculentum* crop.Similiarly crop yield in terms of number of fruits / plant and weight of fruits per plant showed variability for their treated dose. Number of fruits and their weight in Brinjal was found better in enhanced trend till 25% and after that deleterious effect was noted while black gram respond positively only at 5% concentration. Similiarly maximum yield was found in soyabean at 5% concentration and above that deleterious effect was recorded. Progressive and positive trend at all concentration in weight of tomato fruit per plant was found.

Introduction

Due to explosion of population , change in attitude of life and development of high degree of scientific researches have yielded rapid growth of industrialization to fulfil the human need in the last two decades of twentieth century. This phenomenon has generated laterally most serious problem concerned with human health and other welfare. Albeit water consumption in the industries has third rank, but many industries are generating effluent not only of high amount but they contain high level of organic components which act as suitable media for growth and multiplication of both virulent and avirulent micro organism. Both are dangerous , because both are concerned in reducing oxygen level resulting adverse effect on aquatic biota. Pathogenic organisms present in the effluent may cause epidemic if surface water is contaminated with these effluent. Besides this several industries are concerned with such type of product having high toxicity level in their effluent due to existence of chemical or heavy metal salts.

Even after proper treatment , effluent should not be discharged in any aquatic system or near by recreation point in order to control outbreak of any kind of epidemic. But as in our condition where maximum number of cities and industries do not posses adequate treatment plants and it is customy to discharge untreated raw sewage either in aquatic reservoir or on land surface. Since this raw sewage contains high amount of organic component and even treated effluent also posses certain amount of organic components. Both may serve the need of nutritional requirement to the plant as fertilizer. Therefore , in order to find out alternative suitable means of safer sewage disposal as well as minimizing the investment in agricultural cost, the investigation was carried out .

In the light of above and in welfare of the society efforts have been made to utilize the effluent for irrigation in several agricultural crops all over the world, based on the reports made by several workers (Dutta and Boissya 1999; Kumar *et al*. 1997). But certain industrial effluent may contain toxic components, which may inhibit the germination of seed or retard the growth of crop plant (Rajannan and Oblisami, 1979; Bishop 1983; Sahai *et al.*1986 and Swaminathan *et al*. 1989). In the present study an effort has been made to find out influence of star paper mill effluent on biomass and yield of certain agricultural crop i.e. *Solanum melongena* (Brinjal), *Cicer arietinum* (Black gram), *Glycine max*(Soyabean) and *Lycopersicon esculentum* (Tomato) at harvesting time.

Materials and Methods

Composite samples were collected from star paper mill, Saharanpur and were brought to laboratory for analysis. The effluent sample was analyzed for various physico-chemical and microbiological parameters as suggested by APHA (1985) and was further used for the treatment of seeds of test crops. Various concentrations of effluent (5%, 10%, 25%, 50%, 75% and 100%) were prepared by using tap water separately. The seeds of uniform size of each crop were selected and surfaces sterilized with 0.1% mercuric chloride for one minute and were washed thoroughly with distilled water to avoid any traces of $HgCl_2$. These surface sterilized seeds were used for the biomass production and yield with different treated/irrigated concentrations of the effluent.

Biomass production and yield under field conditions

For determining the biomass of the crops (*Solanum melogena, Cicer arietinum, Glycine max* and *Lycopersicon esculentum*) seven plots (1-7) each of the size 18 X 18 inch ^{2} were taken. Ten seeds of each crop treated with different concentrations were sown in each plot. The plots (1-7) were irrigated with 0%, 10%, 25%, 50%, 75% and 100% effluent respectively on alternate days. The percentage of seed germination , root length , shoot length , vigour index and biomass were observed after 21 days from the date of sowing. The experiment was conducted four times.

Seven plot of size 18 X 18 inch ^{2} were used for the study of yield production. In each plot ten seeds were sown and all these plots were irrigated with different concentrations i.e. 0%, 5%, 10%, 25%, 50%, 75% and 100% of effluent on alternate days. Biomass production at harvesting stage of different agricultural crops was measured by considering various parameters i.e. root length , shoot length, root/shoot ratio etc. .Production of yield was recorded in terms of number of fruits on seed production on per plant and weight of the fruit or seeds on per plant. Due to variation in growth rate and germination the yield was recorded at different age in different crops i.e. 160 days for *C. arietinum* and for *G.. max,* 180 days for *L. esculentum* and 240 days for *S. melongena*.

Statistical analysis: The data was statistically analyzed (Levin and Rubin, 1995) using standard deviation and correlation factor.

Results

Results of influence of star paper mill effluent on biomass production and yield have been presented in the table 1 & 2 respectively. Under field conditions , at 21 days data showed variable results on percentage of seed germination and on various parameters related with biomass production (Table-1). Maximum percentage of seed germination i.e. 35 at 25% concentration in brinjal while 90 at 10% concentration in blackgram and 60 at 100% (undiluted effluent) in tomato than control (Table-1) . Lower percentage of seed germination was recorded at all the concentrations than compared to control in soyabean.

Maximum root length (0.91 cm) , shoot length (1.52 cm) , vigour index (54.11) and biomass (47.79 mg/plant) in brinjal while root length (8.15 cm) , shoot length (14.68 cm) , vigour index (1230.99) and biomass (826 mg/plant) were recorded at 25% concentration. In case of soyabean maximum value of root length (6.82 cm) , shoot length (13.13 cm) , vigour index (860.27) at 50% concentration but seed germination (85) and biomass (1334 mg/plant) at 5% concentration. In tomato maximum root length (1.35 cm) , shoot length (2.42 cm) , vigour index (175.95) and biomass (82.91) at 100 % concentration of effluent (Table-1).

Findings of biomass production and yield of above different crops are presented in (Table-2). Maximum value for root length , shoot length , vigour index and biomass were found in the same pattern i.e. maximum value at 25% in brinjal at 240 days. But maximum value for root length , shoot length, vigour index and biomass were found in the plot treated with 10% concentration in black gram and soyabean at age of 160 days each (Table-2). Value for all above parameters were found in same pattern of biomass production at 21 days in tomato crop at harvesting time of 180 days old plant in 100% concentration.

Discussion

Data recorded on biomass production at the age of 21 days and biomass and yield at harvesting stage under field condition treated with different concentration of effluent are presented in (Table 1&2). Results revealed that no definite pattern for seed germination and biomass production at 21 days of treated effluent concentration could be established among the different used crops i.e brinjal , blackgram, soyabean and tomato. Conclusion based on findings could be established that star paper mill contains varying amount of nutrient in the form of organic components which serve the purpose of measured parameters up to certain extent in general but specially in brinjal and blackgram (Table 1). Their nutrient support is found limited upto certain limit in term of their concentration. These findings are in accordance to (Rajanan and Oblisami, 1979; Mishra and Sahoo,1989). However Snehlata (1991) found deleterious effect of induced cadmium on enzyme activity which ultimately effect seed germination.Nutritional support of effluent is found effective upto definite concentration , beyond that with increased concentration of effluent showed deleterious effect in brinjal and black gram.These may be perhaps either due to higher concentration of nutrients along with other inorganic chemicals which showed their significant injurious effect either influencing the physiological mechanism of the crop plants. Declined trend of biomass production at higher concentration dose may also be associated due to minimization of porosity of the soil and decomposition of suspended and dissolved solids.

However, stimulatory effect on seed germination and growth in terms of biomass production could not be recorded in soyabean crop as evident by Table 1.Behaviour of tomato plant in response to treated dose was found different from all other test crop plant. All concentrations

used in the study and even in pure effluent, all parameters have been found an enhanced value.

Variabilities among the different test crops responding to the dose of concentration may also be due to genetic nature related with their genetic style. Biomass and yield under field condition of four above mentioned test crops plants showed similar trend in number of brinjal/ plant and yield in terms of weight was found gradually increased from 5 to 25 % concentration and started declining beyond that.

Varied trend of dose was recorded between biomass at 21 days old black gram crop and yield at harvesting stage. Maximum value was found at 10% at 21 days while maximum yield was found at lowest concentration i.e 5% in case of black gram. It may be due to regular irrigation , which could increase the different components in term of organic , inorganic compounds and salts after 21 days upto a level which was available at 10% concentration.

Similar trend was found in soyabean crop, maximum yield has been found at 5% concentrated effluent. It is totally different from the results of 21 days old crops where effluent showed adverse effect . Positive correlation with concentration of effluent and numbers of tomato per plant and yield in term of weight was found in *L. esculentum.*

Thus it can be concluded that albeit at very low concentration (5%) effluent of star paper mill have not shown any adverse effect on germination , biomass and yield but probability of absorption of chemicals during seed germination was there . Moreover transportation and storing in the system of plants and their products could be avoided. Therefore irrigation of the paper effluent in *C. arietinum* and *G. max* at higher concentration should not be recommended. However paper mill indicate that these effluents contains some nutrients, which fulfill the requirement of manures to the germinating crops upto, certain extent. However before recommending these effluents for irrigation more scientific work is needed regarding deposition of chemical components in the products and also their effects on land surface and biota.

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Table 1: Seed germination and biomass production of four agricultural crops at 21 days under field conditions

Crops	Treatments							
	Parameters	0	5	10	25	50	75	100
Brinjal	SG (%)	22.5	27.5	30	35	20	20	17.5
	RL (cm)	0.45	0.44	0.65	0.91	0.58	0.36	0.31
	SL (cm)	0.54	0.53	0.71	1.52	1.10	0.76	0.48
	R/S	0.83	0.83	0.91	0.59	0.52	0.47	0.64
	VI	12.6	15.01	21.95	54.11	22.58	15.56	8.71
	BM (mg/plant)	42.93	26.52	28.5	47.79	20.75	19.62	2.85
Black Gram	SG (%)	80	86.6	90	83.3	83.3	73.3	50
	RL (cm)	7.85	8.53	8.63	8.15	7.74	4.71	4.45
	SL (cm)	15.8	12.49	15.5	14.68	14.53	12.07	9.89
	R/S	0.49	0.68	0.56	0.55	0.53	0.39	0.44
	VI	1271.85	1090.16	1403.68	1230.99	1218.08	889.44	498.95
	BM (mg/plant)	849.25	1128.75	1008.0	826	723.75	498.95	65.5
Soyabean	SG (%)	90	85	80	75	65	55	50
	RL (cm)	4.35	4.68	5.30	6.82	6.82	5.90	2.84
	SL (cm)	12.73	6.07	9.89	10.48	13.13	11.12	8.55
	R/S	0.34	0.77	0.53	0.64	1.92	0.53	0.33
	VI	1150.05	520.63	796.5	792.81	860.27	617.50	430.34
	BM (mg/plant)	1436.5	1334.0	1231.5	1169.0	1039.75	1002.50	462.75
Tomato	SG (%)	20	20	30	47.5	50	52.5	60
	RL (cm)	0.46	0.44	0.64	0.86	0.82	1.25	1.35
	SL (cm)	1.54	2.91	1.41	2.66	2.42	2.09	2.42
	R/S	0.29	0.45	0.21	0.32	0.33	0.51	0.46
	VI	31.26	28.64	63.34	127.21	121.82	128.30	175.95
	BM (mg/plant)	48	26.67	33.10	38.15	79.22	80.32	82.91

Abbreviation

Seed Germination : SG
Root Length : Rl
Shoot Length : SL
Root/Shoot Length : R/S
Vigour Index : VI
Biomass : Bm

Table 2: Biomass and Yield production of four agricultural crops at harvesting time under field conditions

Crops	Treatments							
	Parameter	0	5	10	25	50	75	100
Brinjal (240days)	RL (cm)	2.30	2.50	2.55	5.35	2.35	2.05	1.85
	Sl (cm)	4.85	2.55	4.40	10.25	4.05	3.30	4.95
	R/S	0.47	0.98	0.57	0.52	0.58	0.62	0.37
	No. of B/Plant	1.8	1.8	4.6	4.8	1.6	1.4	1.2
	Yield of B/Plant	200	160	170	200	102	0.233	0.110
	Dry wt. (mg/ Plant)	123.66 $x10^3$	172.5 $x 10^3$	176.8 $x10^3$	251.33 $x10^3$	144.2 $x10^3$	79.2 $x10^3$	54.5 $x10^3$
Black Gram (160days)	RL (cm)	4.55	8.40	7.35	7.30	6.65	5.60	4.95
	Sl (cm)	15.1	21.50	24.25	15.40	17.00	13.30	15.65
	R/S	0.30	0.39	0.30	0.47	0.39	0.42	0.31
	No. of BG/Plant	33.0	50.6	42.6	41.14	40.3	37.8	21.2
	Yield of BG/Plant	7.0	14.0	13.0	11.0	10.7	10.3	3.0
	Dry wt. (mg/ Plant)	$49.^8$ $x10^3$	6^7 $x10^3$	54.8^5 $x10^3$	45.7^5 $x10^3$	$45.^4$ $x10^3$	3^7 $x10^3$	3^2 $x10^3$
Soyabean (160 days)	RL (cm)	7.35	11.75	10.25	10.20	9.50	9.50	8.85
	Sl (cm)	20.25	25.55	18.15	17.70	21.85	12.10	18.60
	R/S	0.36	0.45	0.56	0.57	0.43	0.78	0.47
	No. of Sb/Plant	5.88	27.87	20.85	16.62	14.12	11.5	8.33
	Yield of Sb/Plant	25.0	90.0	75.0	75.0	70.0	40.0	15.5
	Dry wt. (mg/ Plant)	3 x 10^3	10.6 x 10^3	9.3 x 10^3	7.5 x 10^3	6.4 x 10^3	4.5 x 10^3	2.2 x 10^3
Tomato (180 days)	RL (cm)	8.65	5.35	5.50	6.15	6.40	7.80	11.70
	Sl (cm)	29.0	22.10	25.95	21.50	19.05	21.20	26.90
	R/S	0.29	0.24	0.21	0.28	0.33	0.36	0.43
	No. of T/Plant	10.7	8.4	9.83	9.85	10.57	12.0	19.6
	Yield of T/Plant	0.195	0.245	0.494	87.5	93.0	117.85	142.85
	Dry wt. (mg/ Plant)	153.33 $x10^3$	89.28 $x10^3$	130.71 $x10^3$	136 $x10^3$	209.16 $x10^3$	222.4 $x10^3$	335 $x10^3$

Abbreviation

B : Brinjal BG : Black Gram
Sb : Soyabean T : Tomato